4. The SCP returns the Location Routing Number (LRN) of the Dialed Number.
5. The originating office routes the call to the recipient's end office.

5.0 Feature Operation at Initiating Switch

5.1 Initiation

QoR activates at the Information Analyzed Detection Point (DP) of the Originating Basic Call Model. Subject to the escape criteria in section 5.2, QoR should be engaged on any call to a DN in a portable NPA-NXX against which QoR is enabled.

5.2 Escape Criteria

QoR shall apply the same escape criteria as the LRN trigger. These escape criteria are summarized below:

QoR shall not be initiated if the call can be completed intraswitch (i.e., if the called DN is equipped on the same switch that contains the originating call).

QoR shall not be initiated if the call is interLATA, or the call is intraLATA toll and the current service provider is not the designated carrier for the call. Instead, the call should be routed to the appropriate interexchange carrier.

QoR shall not be initiated if the call requires operator handling (e.g.,on 0-, 0+ or coin calls). Instead, the call should be routed to the appropriate operator service center.

QoR shall not be initiated if the call originates from an ISUP trunk and the IAM message contains an FCI parameter within which the *Translated Called Number Indicator* Field is set to *Number Translated*.

QoR should not be initiated if the call originates from an ISUP trunk and the IAM message contains an FCI parameter within which the *Routing Attempt Indicator* field is set to *Routing Attempt in progress*.

5.3 Precedence

Switch-based features operating within the Analyze Information Point In Call (PIC) take precedence over QoR:

- QoR should not be initiated if the call is blocked because of code- or toll-restrictions;
- QoR should not be initiated if the call encounters code- or toll-diversion;
- QoR should not be initiated if the call is blocked by station dialling restrictions;
- QoR should not be initiated if the call encounters network management code blocking;
- QoR should operate normally during Automatic CallBack and Recall attempts once TCAP processing indicates that the call can proceed.

AIN PODP triggers at the Information Analyzed DP take precedence over QoR. QoR may be initiated after a PODP trigger if the switch receives a *Continue* operation in response to the AIN query. Similarly, QoR may be initiated if the switch receives an *Analyze Route* operation in response to a PODP query, the *Analyze Route* operation indicates LEC routing

or does not include carrier information, and the *Analyze Route* operation supplies a new Called DN with an NPA-NXX eligible for QoR.

QoR takes precedence over LNP triggers including those at the Information Analyzed DP. The LNP trigger may be encountered should the QoR routing attempt prove unsuccessful. (If convenient, the QoR can be conceptualized as an option associated with the six-digit AIN LNP trigger definition.)

QoR takes precedence over IN LNP triggers. The IN LNP trigger may be encountered subsequently should the QoR routing attempt prove unsuccessful. If convenient, the QoR can be conceptualized as an option associated with the six-digit IN LNP trigger definition.

QoR takes precedence over LNP triggers at the Termination Attempt DP, i.e., QoR takes precedence over the OCT LNP trigger.

5.4 Operation

QoR's operation is described in three parts:

- launching the routing attempt to the donor switch;
- receiving a call-proceeding indication; and
- receiving a release indication.

5.4.1 QoR routes to donor switch

Once activated, QoR selects a route to the donor switch associated with the called DN.

QoR should choose the same route as would be selected when the switch processes an LNP response message for a non-ported DN in the same NPA-NXX (i.e., were QoR disabled for the NPA-NXX in question, routing would proceed identically on receipt of an LNP response message without an LRN).

As an objective, QoR should ensure that the selected route references ISUP facilities. If the QoR routing attempt egresses from the initiating switch over MF facilities, QoR terminates (as the MF connection cannot be released from the call path) and the call proceeds as a regular MF trunk call. The remaining requirements in this section assume that the routing attempt is undertaken over ISUP facilities. Refer to Section 8 for more information on MF interworking.

For Originating Call Model LNP triggers, QoR bypasses these triggers at the Information Analyzed DP. Call-processing resumes at the Select Route PIC using the route supplied by QoR.

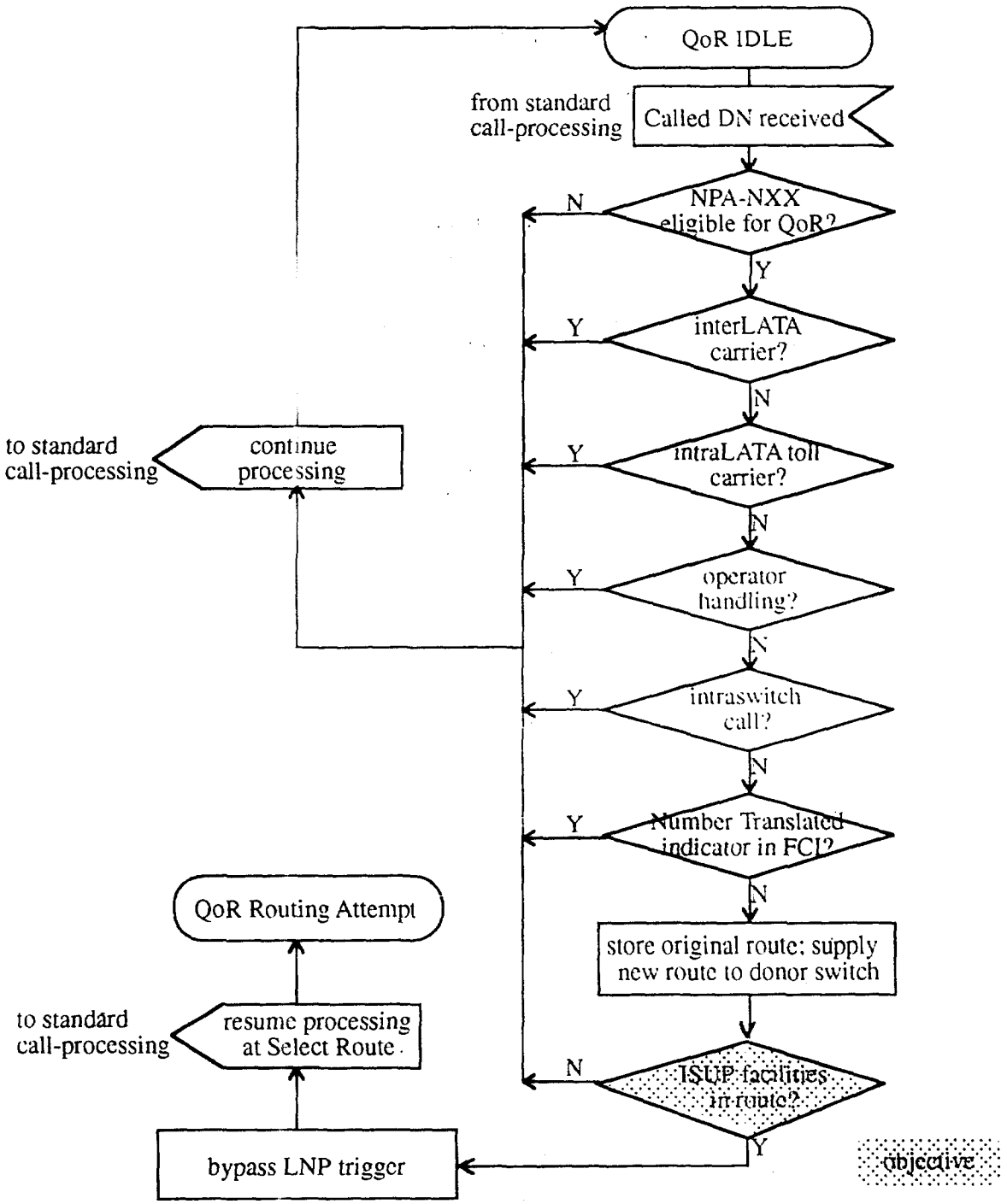
For the OCT LNP trigger, QoR forces the call to terminate on a route (trunk) to the donor switch rather than a DN at the originating switch, bypassing the OCT LNP trigger at the Termination Attempt PIC. OCT is encountered only on DN terminations.

Call-processing selects an idle ISUP circuit, formulates an ISUP IAM message according to the procedures set forth in GR-317 and GR-444, and sets the Routing Attempt indicator in the IAM FCI parameter to *Routing Attempt in progress*. Setting this field will

- inhibit an LNP query at a succeeding switch[1], and
- coerce a succeeding switch to release the call connection if the QoR routing attempt fails.

Call-processing sends the ISUP IAM message and waits for a reply. On receipt of an ISUP ACM or ANM, QoR proceeds as described in section 5.4.2; on receipt of an ISUP REL, QoR proceeds as described in section 5.4.3.

[1] A succeeding switch that lacks the software necessary to recognize the QoR *Routing Attempt* indicator may launch an LNP query during a QoR routing attempt. Section 14 describes an optional transitional QoR signalling capability to eliminate these unwanted LNP queries.

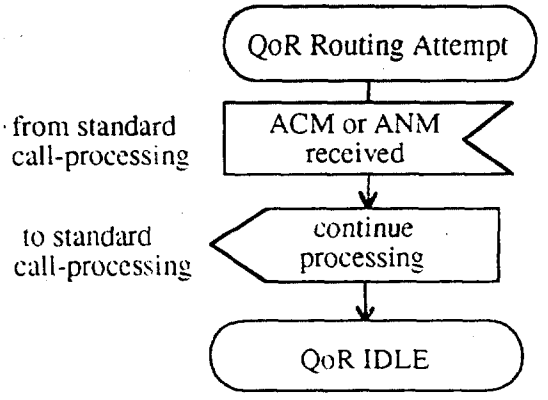

QoR IDLE
from standard call-processing
Called DN received
NPA-NXX eligible for QoR?
N
Y
interLATA carrier?
Y
N
intraLATA toll carrier?
Y
N
operator handling?
Y
N
intraswitch call?
Y
N
Number Translated indicator in FCI?
Y
N
store original route; supply new route to donor switch
ISUP facilities in route?
N
Y
to standard call-processing
continue processing
QoR Routing Attempt
to standard call-processing
resume processing at Select Route
bypass LNP trigger
objective

If an idle trunk circuit is not available at the QoR-initiating switch to perform the QoR routing attempt, the switch shall proceed based on the requirements in section 5.4.3 as though it had received an ISUP RELease with *cause 34, no circuit available* (except in this case there is no outgoing ISUP circuit to idle).

5.4.2 QoR receives a call-proceeding indication

QoR interprets an ISUP ACM or ANM as an indication that the routing attempt is proceeding. QoR terminates (ends) on receipt of either an ACM or ANM, and the call is handled by standard call-processing thereafter.

Note: Receipt of an ISUP ACM may also be an indication that the call has encountered MF interworking; please see Section 8 for more information.



5.4.3 QoR receives a release indication

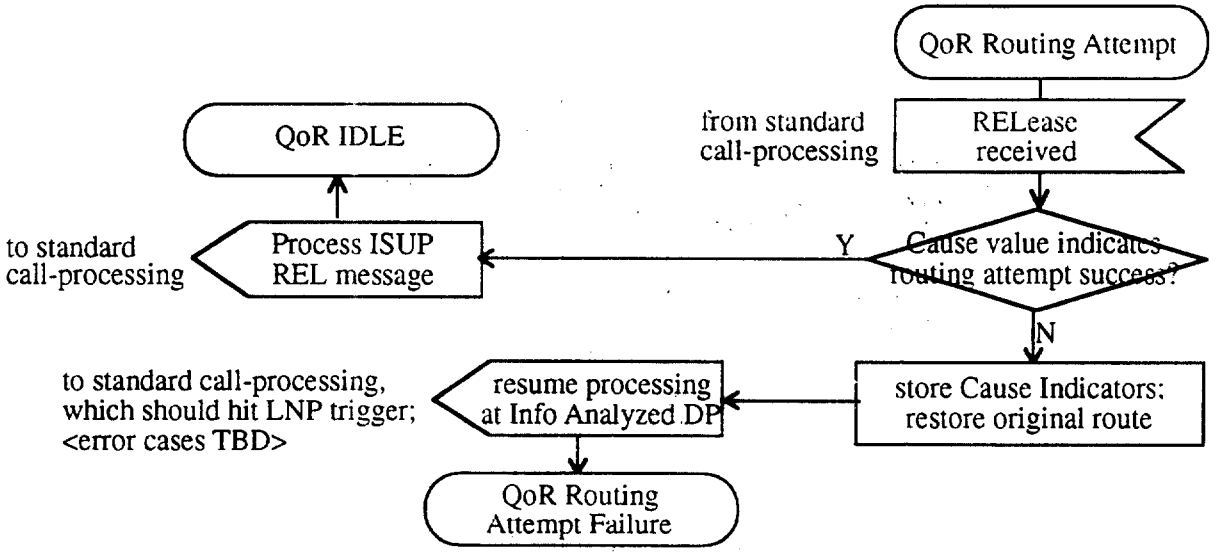
On receipt of an ISUP REL message from a succeeding switch, standard call-processing at the QoR switch should release and idle the outgoing ISUP circuit, and formulate and send an RLC message to the succeeding switch (according to the procedures outlined in GR-317 and GR-444). QoR should then inspect the mandatory Cause value in the ISUP REL message to determine whether an LNP query should be undertaken for the call:

- the QoR-initiating switch shall support an administrable list of ISUP REL Cause values for which an LNP query should be undertaken
- the default set of Cause values appearing in the list shall include *cause #1 — unallocated number*.
- the service provider may, at its discretion, include additional Cause values in the list, for instance to generate LNP queries on calls blocked by network management code controls, calls that encounter network busy condition, or calls that encounter temporary failures[2].

If the cause value in the ISUP REL message does not appear in the list of Cause values for which an LNP query should be undertaken, the QoR operation terminates and standard call-

[2] Querying on receipt of Cause values in the *Resource Unavailable Class* can maximize call completion to ported DNs, but at the cost of increasing network processing in times of congestion.

processing is left to clear the call to the originating access or preceding switch using the procedures in GR-317 and GR-444.



If the Cause value in the ISUP REL message appears in the list of Cause values for which an LNP query should be undertaken, QoR shall

- restore the original route supplied by digit-analysis (which may or may not be a route to the donor switch), and
- direct the Originating Basic Call Model to resume processing within the Information Analyzed DP, at the point immediately following QoR's initiation. This applies to both the OCT and Originating Call Model triggers.

The call is expected to then either:

- encounter a Originating Call Model LNP trigger (on switches that support this implementation of LNP);
- encounter an IN LNP trigger (on switches that support this implementation of LNP); or
- terminate to an open NPA-NXX on switch and encounter a TAT-like LNP trigger (on switches that support this implementation of LNP).

LNP trigger and response processing shall proceed based on the requirements in FSD 30-12-0001:

- if the LNP response indicates that the Called DN has not ported[3] (i.e.does not contain an LRN), the switch shall route the call to the donor switch. In the ensuing ISUP IAM, the *Translated Called Number Indicator* field of the FCI parameter shall be set to *Number Translated*, and the *Routing Attempt* indicator shall be set to *no routing attempt in progress*.

[3] In most cases, an LNP response indicating that the Called DN has not ported implies that the Called DN is vacant— because the QoR routing attempt has (generally) already established that the Called DN is not equipped at the donor switch.

- if no response is received from the LNP SCP, or the response from the LNP SCP contains a fatal error, the switch shall route the call to the donor switch. In the ensuing ISUP IAM, the *Translated Called Number Indicator* field of the FCI parameter shall be set to Number Not Translated, and the *Routing Attempt* indicator shall be set to *no routing attempt in progress*.

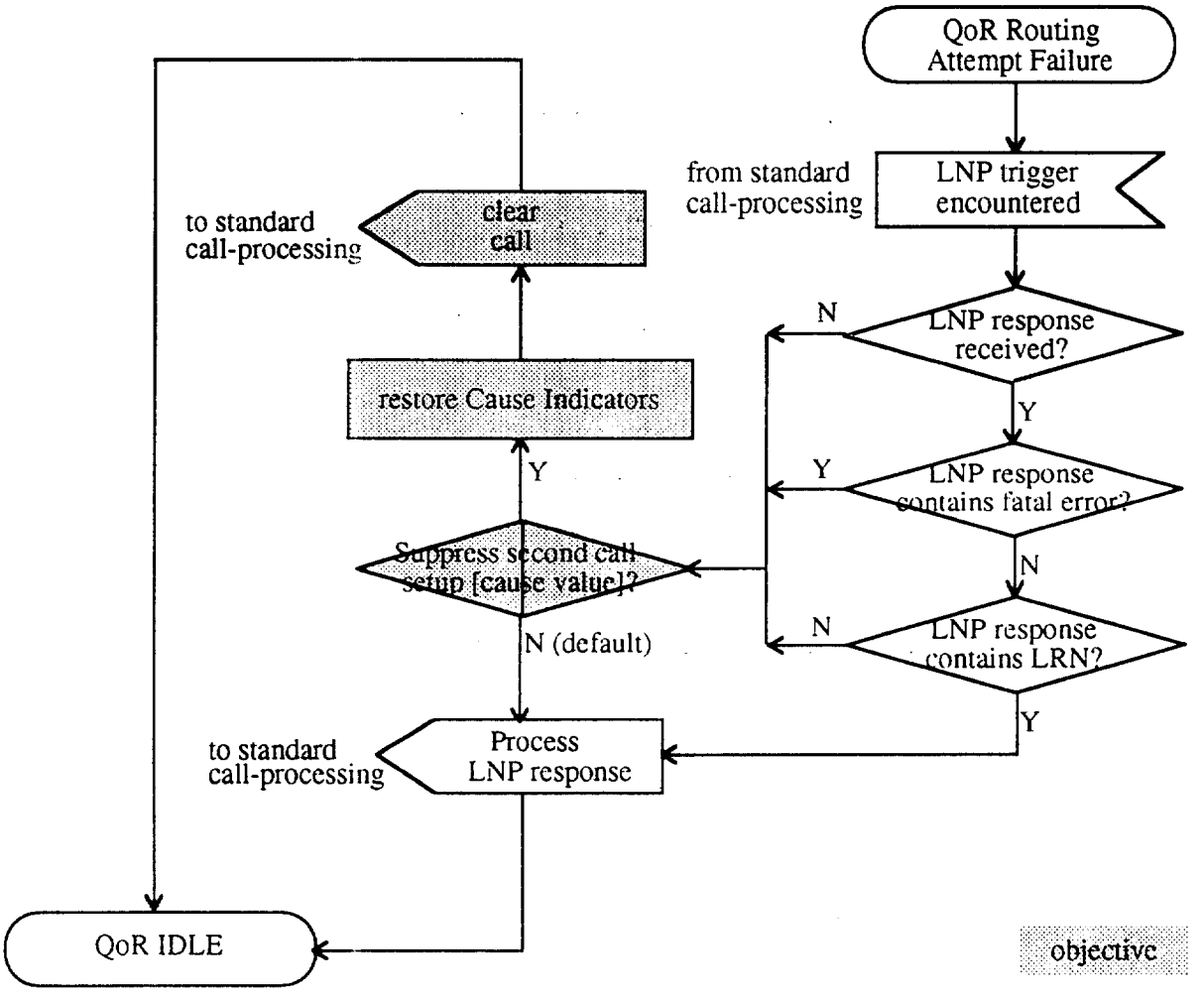
- if the LNP response contains an LRN, the switch shall route the call to the recipient switch. In the ensuing ISUP IAM, the *Translated Called Number Indicator* field of the FCI parameter shall be set to *Number Translated*, the *Routing Attempt* indicator shall be set to *no routing attempt in progress*, and a GAP shall identify the ported DN.

Note that a call to a vacant DN results in two call-setups to the donor switch: the first—a QoR routing attempt, and the second—a regular call attempt following the LNP query. The second call-setup allows the donor switch to provide special vacant number intercept treatment. The donor switch is deprived of this opportunity during the QoR routing attempt because the *Routing Attempt* indicator in the ISUP IAM FCI coerces the donor switch to release the call.

A call to non-ported DN where the QoR routing attempt is blocked before reaching the donor switch (e.g., because of network management code controls at an intermediate switch) may also result in two call-setups toward the donor switch[4]. Again, the second call-setup allows the blocking switch to apply treatment locally.

As an objective, the QoR initiating switch shall be able to suppress a second call-setup toward the donor office based on the RELease cause value resulting from the QoR routing attempt (i.e., the cause values that suppress a second call-setup shall be administrable at the QoR-capable switch, and the default set shall be empty). In cases where the second call-setup is suppressed, the QoR switch shall instead clear the call based on the RELease cause value resulting from the QoR routing attempt, following the procedures outlined in GR-317 and GR-444.

[4] Two call-setup attempts will result if the service provider elects to include *Resource Unavailable Class* cause values in the list of RELease cause values that give rise to an LNP query.



6.0 Feature Operation at Intermediate Switch

An intermediate switch can distinguish a QoR routing attempt from a regular call attempt by examining the *Routing Attempt* indicator in the ISUP IAM FCI parameter. The intermediate switch shall assume that a QoR routing attempt is underway if

- the *Routing Attempt* indicator is set to *routing attempt in progress.*

An intermediate switch shall assume that a QoR routing attempt is not underway if the call originates from non-ISUP facilities.

On receipt of a QoR routing attempt, the intermediate switch shall attempt to route the call toward the donor switch. If the intermediate switch is unable to route the call toward the donor switch (because, for example, of network congestion controls, resource unavailabilities or temporary failures), it shall RELease the call in the backward direction instead of applying treatment locally.

If the intermediate switch delivers the QoR routing attempt to an outgoing ISUP trunk-group that has assigned the *signal ported number* option, the intermediate switch shall

- set the *Translated Called Number Indicator* field to *Number Not Translated*, and
- set the *Routing Attempt* indicator to *no routing attempt in progress*.

If the intermediate switch engages a supplementary service that generates an ISUP ACM or ANM (e.g., an AIN *Send To Resource* operation) during a QoR routing attempt, it shall reset the *Routing Attempt* indicator to the default values. (Recall that the switch initiating QoR will discontinue QoR on receipt of an ACM or ANM— see section 5.4.2.) This will allow the intermediate or a succeeding switch to encounter an LNP trigger or initiate a new QoR routing attempt.

An intermediate switch that lacks the software necessary to recognize the QoR Routing Attempt indicator may launch an unwanted LNP query during a QoR routing attempt. Section 14 describes an optional interim QoR signalling capability that can be invoked by the QoR-initiating switch to eliminate these unwanted LNP queries.

Caution: A QoR routing attempt should not be directed toward an intermediate switch that lacks the software necessary to recognize the new *Routing Attempt* indicator in the ISUP IAM FCI, unless the switch can be administered to release the ISUP connection by other means if the QoR routing attempt is blocked.

Caution: QoR routing attempts directed to intermediate switches that do not recognize the *Routing Attempt* indicator may not complete successfully if a supplementary service engaged at the intermediate switch generates an ISUP ACM or ANM.

7.0 Feature Operation at Donor Switch

A donor switch can distinguish a QoR routing attempt from a regular call attempt by examining the *Routing Attempt* indicator in the ISUP IAM FCI parameter. The donor switch shall assume that a QoR routing attempt is underway if

- the *Routing Attempt* indicator is set to *routing attempt in progress*

The donor switch shall assume that a QoR routing attempt is not underway if the call originates from non-ISUP facilities.

On receipt of a QoR routing attempt, the donor switch shall attempt to terminate the call to the DN in the ISUP CdPN parameter. If the called DN is not equipped at the donor switch, it shall RELease the call in the backward direction instead of applying treatment locally[5].

If the donor switch engages a supplementary service that generates an ISUP ACM or ANM (e.g., an AIN *Send To Resource* operation) during a QoR routing attempt, it shall reset the *Routing Attempt* indicator to the default values. (Recall that the switch initiating QoR will discontinue QoR on receipt of an ACM or ANM— see section 5.4.2.) This will allow the donor switch to encounter an LNP trigger should the called DN be marked as vacant.

[5] The donor switch need not RELease the connection if it can determine conclusively that the called DN is vacant as opposed to ported —in this case, it is more efficient not to force the donor switch to RELease the call, since a second call-setup attempt will ensue. (See section 5.4.3 for more information.)

A donor switch that lacks the software necessary to recognize the QoR *Routing Attempt* indicator may launch an LNP query during a QoR routing attempt to a ported DN. Section 14 describes an optional interim QoR signalling capability that can be invoked by the QoR-initiating switch to eliminate these unwanted LNP queries.

Caution: A QoR routing attempt should not be directed toward a donor switch that lacks the software necessary to recognize the new *Routing Attempt* indicator in the ISUP IAM FCI, unless the switch can be administered to release the ISUP connection by other means if the called DN is marked as vacant.

Caution: QoR routing attempts directed to a donor switch that does not recognize the *Routing Attempt* indicator may not complete successfully if the called DN has ported, and a supplementary service engaged at the donor switch generates an ISUP ACM or ANM.

8.0 MF Interworking

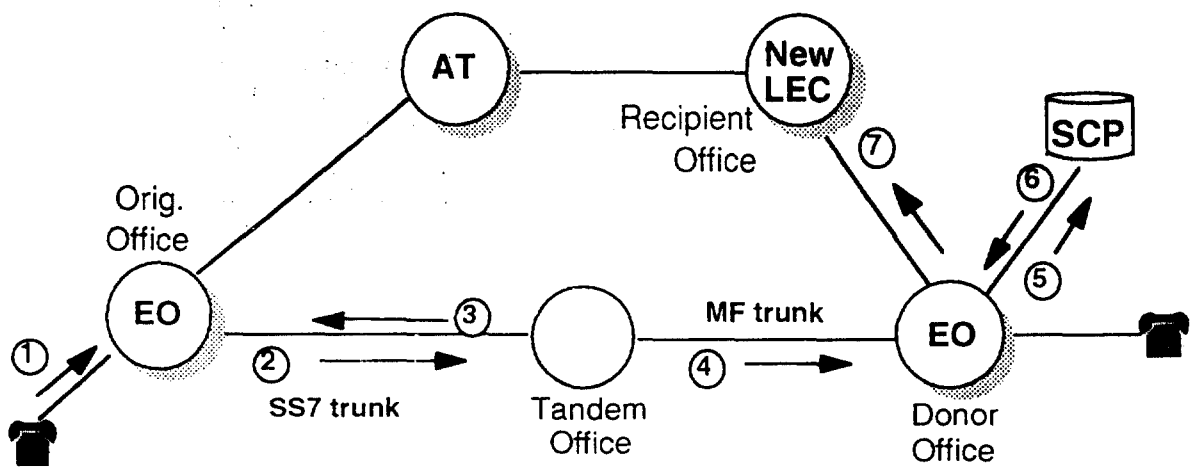
QoR routing attempts may encounter MF interworking, in which case an ISUP ACM is sent from the interworking switch to the QoR-initiating switch, causing QoR to terminate.

An LNP-capable switch receiving a routing attempt over MF facilities will recognize it as a call to a portable NPA-NXX. And because Forward Call Indicators (including the *Translated Called Number Indicator* field therein) are not signalled over MF facilities, the LNP-capable switch will either launch an LNP query based on the procedures in FSD-30-12-0001, or initiate a new QoR based on the procedures in this document. (It is assumed that at least one LNP-capable switch will be encountered after MF-interworking, or that the donor switch, if not LNP-capable, will provide some alternative mechanism to reroute calls to DNs that have ported from it).

Caution: Trunk tromboning may result if QoR routing attempts encounter MF interworking.

The network flow for mixed MF and SS7 networking is shown below:

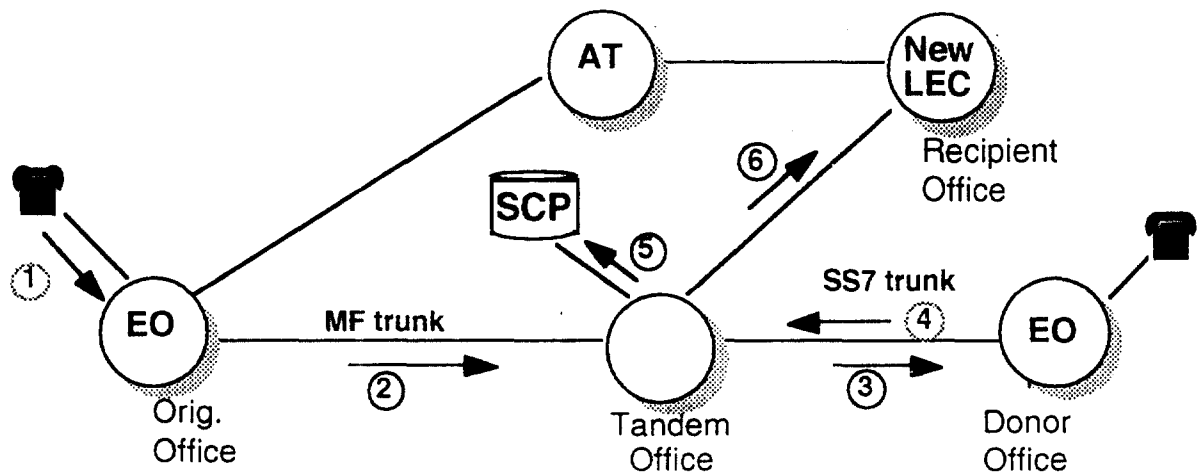
Figure 2: Network Flow for Mixed MF / SS7 - 1



For a network scenario with a mixture of MF and SS7 trunks as depicted in Figure 2 above, the call flow would be as follows:

1. The originating switch attempts to set up the call to the donor switch.
2. An IAM is sent to the tandem office via SS7.
3. The tandem office determines that outpulsing will be done on an MF trunk and sends back an ACM to the originating switch. The originating switch then ends the QoR attempt and resumes standard call processing.
4. The tandem outpulses to the donor office over the MF trunk.
5. The donor does not receive the FCI, and therefore sends an LNP query to the SCP.
6. The SCP returns the LRN response.
7. The donor completes the call to the recipient office.

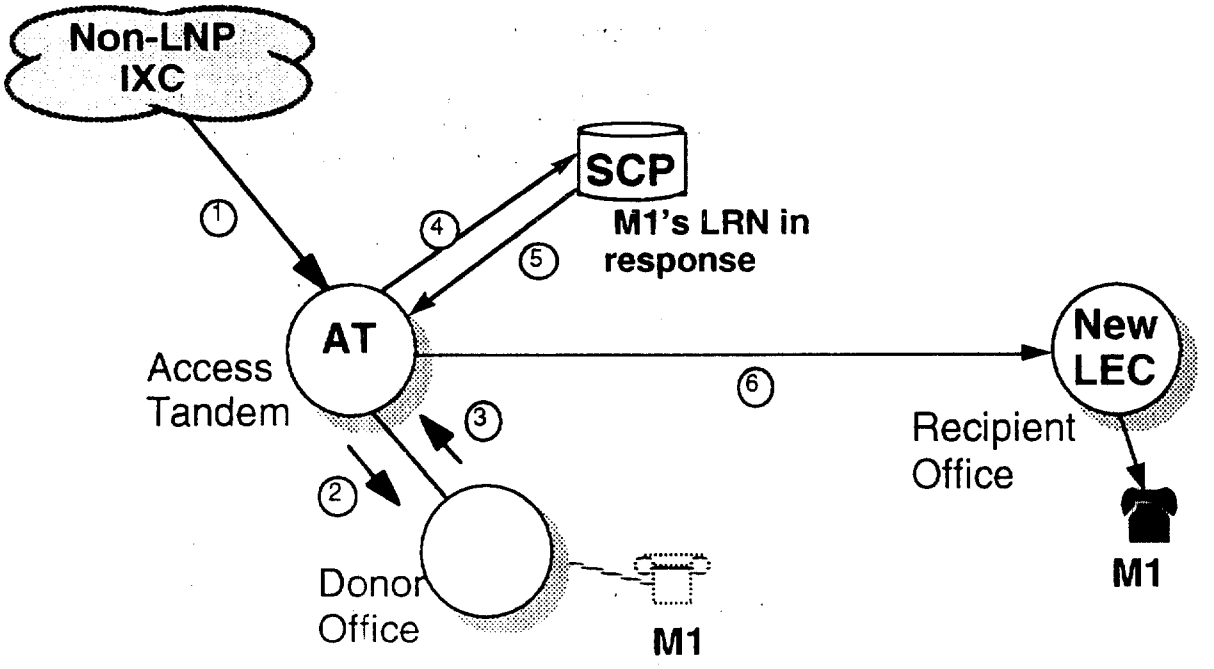
Figure 3: Network Flow for Mixed MF / SS7 - 2



For a network scenario with a mixture of MF and SS7 trunks as depicted in Figure 3 above, the call flow would be as follows:

1. The originating switch attempts to set up the call to the donor switch
2. The originating office outpulses to the tandem office over the MF trunk
3. The tandem does not receive the FCI, so it initiates a QoR operation of its own, based on the dialled number
4. If the DN is ported, the donor responds to the tandem with RELease
5. The tandem responds to the RELease with a query to the SCP
6. The tandem completes the call to the recipient office

Figure 4: Toll Calls from a Non-LNP Capable IXC Switch



For toll calls from a non-LNP capable IXC switch, the call flow would proceed as follows:

1. An incoming call is initiated from a non-LNP capable IXC to M1
2. The access tandem initiates a Query on Release to the donor switch
3. The donor switch responds with an ISUP RELease with Cause = Unallocated Number
4. The access tandem responds to the RELease message and launches a query the the LNP SCP
5. The SCP provides an LRN response
6. The call is routed to the recipient switch.

9.0 Provisioning

QoR-capable switch:

The following items should be administrable at the QoR-capable switch:

- for each portable NPA-NXX, an indication of whether QoR applies;
- the set of QoR ISUP RELease cause values that should give rise to an LNP query;
- as an objective, the set of ISUP Cause values for which a second call-setup to the donor switch should be suppressed if the LNP query indicates that the called DN has not ported.

Intermediate switch:

QoR does not require special provisioning at intermediate switches equipped with the software necessary to recognize the new *Routing Attempt* indicator.

Intermediate switches that do not recognize the new *Routing Attempt* indicator but receive QoR routing attempts must be provisioned to apply treatments remotely (i.e., send an ISUP REL message) on calls that are blocked because of network management controls, resource unavailabilities or temporary failures.

Donor switch:

QoR does not require special provisioning at donor switches equipped with the software necessary to recognize the new *Routing Attempt* indicator.

Donor switches that do not recognize the new *Routing Attempt* indicator but receive QoR routing attempts must be provisioned to apply treatments remotely (i.e., send an ISUP REL message) on calls that are blocked because of network management controls, resource unavailabilities or temporary failures.

Donor switches that do not recognize the new *Routing Attempt* indicator but receive QoR routing attempts must be provisioned to apply treatments remotely (i.e., send an ISUP REL message) on calls to DNs marked as vacant[6].

10.0 Operational Measurements

The QoR-capable switch shall keep the following traffic measurements:

i) number of QoR routing attempts initiated by this switch;

ii) number of failed QoR routing attempts initiated by this switch (i.e., number of QoR routing attempts that require a subsequent LNP query);

iii) number of QoR routing attempts initiated by this switch that encounter interworking.

As an objective, the switch shall maintain these measurements on a per NPA-NXX (or equivalent) basis.

Additional traffic measurements may be required. Further input from the industry is needed.

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[6] The donor switch need not RELease the connection if it can determine conclusively that the called DN is vacant as opposed to ported—in this case, it is more efficient not to force the donor switch to RELease the call, since a second call-setup attempt will ensue. (See section 5.4.3 for more information.)

11.0 Billing

No QoR-specific billing requirements have been identified in this release of this document. Further input from the industry is needed.

A switch initiating a QoR routing attempt shall follow existing rules governing the generation of switch-based charge and access records. If the QoR routing attempt succeeds, the resulting AMA record shall be indistinguishable from that of a call placed to a DN in a non-portable NPA-NXX.

If the QoR routing attempt fails and an LNP query is undertaken, the switch shall follow the AMA requirements set forth in *FSD 30-12-0001 Generic Switching and Signaling Requirements for Number Portability*. In particular, a terminating LNP AMA module may be appended to the existing switch-based charge or access record associated with the call.

12.0 Feature Interactions

The *Routing Attempt* indicator in the ISUP Forward Call Indicators parameter shall be reset to *no routing attempt in progress* if

- the call is redirected because of a switch-based forwarding feature (e.g., call-forward variable, call-forward busy, call-forward no answer); or
- the call is redirected because of an SCP-based Analyze Route or Forward Call operation (i.e., one that supplies a new *Carrier* or *Called Party Number* parameter); or
- the call encounters a supplementary service that generates an ISUP ACM or ANM message (e.g., an AIN Send To Resource operation); or
- the call is directed over a trunk-group that has assigned the *signal ported number* option.

A switch receiving a QoR routing attempt (indicated by an FCI value of *routing attempt in progress*) shall escape LNP triggers and shall not launch an LNP query. Alternatively, the switch may support the assignment of a *Routing Attempt Indicator* escape criteria against the LNP trigger; in this case, the switch shall launch an LNP query during a QoR routing attempt only if the escape criteria is not assigned to the trigger.

Further investigation is required in this area.

13.0 Signalling Requirements

QoR adds a new *Routing Attempt Indicator* to the ISUP IAM Forward Call Indicators parameter.

H	G	F	E	D	C	B	A
P	O	N	M	L	K	J	I

Bit M: Translated Called Number Indicator
0—number not translated
1—number translated

Bit N: Routing Attempt indicator
0—no routing attempt in progress
1—routing attempt in progress

Decoupling of the M and N bits is currently under review.

14.0 QoR Interim Capability

This section describes an optional interim capability to suppress unwanted LNP queries, during QoR routing attempts, at intermediate and donor switches without the software necessary to recognize the *Routing Attempt Indicator* field in the ISUP IAM FCI parameter.

The interim capability takes the form of an option at the QoR-initiating switch. The option can be assigned to each portable NPA-NXX for which QoR is enabled. If the option is assigned, the *Translated Called Number Indicator* shall be set in the outgoing ISUP IAM FCI during QoR routing attempts. This will prevent LNP-capable intermediate and donor switches from launching LNP queries.

Once intermediate and donor switches have been upgraded with the software necessary to recognize the *Routing Attempt Indicator* in the ISUP IAM FCI, the QoR-initiating switch should remove the option and disable the capability.

15.0 Issues for Further Study

The following issues remain open:

- Is there a need to block QoR routing attempts that cross network boundaries?
  What provisioning would be needed at switches to achieve this?
  Can this be managed on a per NPA-NXX basis?

16.0 Restrictions and Limitations

QoR is discontinued when a routing attempt encounters MF interworking.

QoR is discontinued when a routing attempt engages a supplementary service that generates an ISUP ACM or ANM.

17.0 Glossary and Abbreviations

ACD	Automatic Call Distribution
ACM	Address Complete Message
AIN	Advanced Intelligent Network
AMA	Automatic Message Account
ANM	ANswer Message
AT	Access Tandem
CFRA	Call Forward Remote Activation
DISA	Direct Inward System Access
DN	Directory Number
Donor Switch	End Office which has had numbers ported from it
DP	Detection Point
EKTS	Electronic Keyset Telephone System
EO	End Office
Equipped DN	A DN that is associated with line equipment, an access trunk, an intercept treatment, or with a switch- or SCP-based feature such as AIN 0.0, RCF, DISA, CFRA, MADN, EKTS, UCD, ACD or Hunting.
FCI	Forward Call Indicators
GAP	Generic Address Parameter in IAM on ISUP trunk
IAM	Initial Address Message
IN	Intelligent Network
Initiating switch	A switch that invokes the QoR capability.
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
LATA	Local Access and Transport Area
LEC	Local Exchange Carrier

LNP	Local Number Portability
LRN	Location Routing Number
MADN	Multiple Appearance Directory Number
MF	Multi-Frequency
N-1	indicates the next-to-last service provider (network) in a call. Would refer to the originating network if there are only two networks involved. In the case of an interLATA call, for example, the next to last network is the interexchange carrier network.
NPA	Numbering Plan Area
PODP	Public Office Dial Plan
QoR	Query on Release
QoR-capable switch	A switch with the software necessary to perform QoR.
RCF	Remote Call Forwarding
RI	Route index
Routing attempt	The trial termination to the donor switch undertaken by QoR before querying the LNP SCP.
SCP	Service Control Point
TAT	Termination AttempT
UCD	Uniform Call Distribution